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# Species Composition of Understory Flowering Plants in the Permanent Plot of Balinsasayao Twin Lakes Natural Park, Negros Oriental, the Philippines

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**The established 2-ha permanent plot of Balinsasayao Twin Lakes Natural Park (BTLNP) in Negros Oriental, the Philippines, is endowed with a variety of plants. Despite the importance of understory flowering plants, their species conservation status in the area remained undocumented, hindering effective monitoring. This study aimed to fill this knowledge gap by surveying the understory flowering plants within the 2-ha permanent plot of BTLNP. The findings will provide a foundation for conservation efforts, long-term monitoring, and future research, complementing existing studies on tagged tree species. This is the first report on the checklist of understory flowering plants in the 2-ha permanent plot of BTLNP. A plot sampling method, repeated transect walks, and opportunistic sampling along forest trails were used to record and determine the understory flowering plants in the area. A survey of understory flowering plants revealed 101 species, representing 74 genera and 33 families. The most abundant families were Rubiaceae (12%), Araceae and Orchidaceae (11% each), and Zingiberaceae (8%). Conservation assessments showed two threatened species: *Hedychium philippinense* (endangered) and *Aeschynanthus truncatus* (vulnerable). Notably, 18 species (0.37% of the Philippines' endemic vascular flora) were found to be Philippine endemics. These understory plants provide crucial microhabitats and food sources for various fauna, highlighting their importance for ongoing monitoring and conservation efforts.**

Keywords: herbs, lianas, epiphytes, Philippine endemics, threatened species, vines

## INTRODUCTION

Biodiversity is crucial for maintaining ecosystem services (Cardinale *et al.* 2012; Isbell *et al.* 2017). Notably, the Philippines is home to a significant proportion of unique flora and fauna, with 57% of major groups found nowhere else in the world (Oliver and Heaney 1996). However, the conservation of plant diversity has been relatively neglected in comparison to animal conservation, potentially attributed to the lower public appeal of plants *versus* more animal groups (Goettsch *et al*. 2015). Species decline has intensified dramatically over the past 50 years, but hints of recovery are starting to emerge (Bell

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*et al.* 2015). The vascular plants in the Philippines are comprised of 10,117 species – of which 9,557 species are native, and 557 species are being naturalized (Pelser *et al.* 2011 onwards).

One of the components of angiosperms is the group of understory flowering plants (angiosperms found below the canopy cover and above the ground), which are mostly composed of herbs, vines, lianas, and other plant species under the forest canopy (Acma *et al.* 2021). Understory species provide diversity and contribute to erosion control and nutrient capture (Gilliam 2007). The understory plant communities are valuable indicators of forest ecosystem health (Tremblay and Larocque 2001; Kerns and Ohmann 2004), biodiversity, habitat potential, umbrella species sustainability, global change impact, and disturbance risk assessment (Suchar and Crookston 2010).

Balinsasayao Twin Lakes Natural Park (BTLNP) is one of the 13 long-term ecological research (LTER) sites in the Philippines (ILTER 2024) and is considered a wildlife sanctuary since several species are found in the area. With two lakes, *viz*. Lake Balinsasayao and Lake Danao, it has a total land area of 8,016,65 ha and an elevation ranging between 750–1,700 masl (Aureo *et al*. 2021). Recently, Aureo *et al.* (2021) studied the floristic composition in the area and recorded a total of 351 species of vascular plants, whereas Jose *et al.* (2021) reported 10 species of bats distributed to three different families. In this study, the 2-ha permanent plot of BTLNP – which was established to monitor the changes of tree species in the area – did not include the understory flowering plants for monitoring. Thus, this study aimed to record the species of understory flowering plants within the permanent plot of BTLNP in Negros Oriental to provide basic information about the diversity and as the basis for long-term monitoring.

## METHODOLOGY

### Entry Protocol

This study was conducted from 24–30 Aug 2023 and 28 Apr–04 May 2024 after the acquisition of the Wildlife Gratuitous Permit (WGP 0325) on 23 Jul 2023 from the office of the Department of Environment and Natural Resources (DENR) in Region VII (Central Visayas) in Dumaguete City, Negros Oriental, the Philippines. A memorandum of agreement was also forged among the different organizations and institutions near the BTLNP such as Philippine Biodiversity Conservation Foundation (PhilBio), Negros Oriental State University (NOrSU), and Silliman University–Angelo King Center for Research and Environmental Management (SUAKCREM).

### Site Description

BTLNP (9°21’11’’N, 123°10’25’’ E) is located in Sibulan, Negros Oriental in Central Visayas at an elevation of 700–1700 masl. BTLNP was declared a protected area under the Republic Act No. 11038 of 2018 and is one of the 13 LTER sites in the Philippines. Within the BTLNP, the 2-ha permanent plot of LTER is located adjacent to the jump-off area of the site and can be reached by walking for 3 min. The permanent plot is a forest-over-rock vegetation covered by growing native trees as a result of being a secondary forest. The area is dominantly represented by tree species *Pterophylla hutchinsonii* (Merr.) Pillon & H.C.Hopkins (Cunoniaceae), *Astronia* sp. (Melastomataceae), and *Ficus* spp. (Moraceae).

### Establishment of Study Area and Field Sampling

Inventory and assessment of understory flowering plants were carried out within the 2-ha permanent plot of LTER, which is part of the monitoring project of Central Mindanao University and Silliman University. Mixed methods of plot sampling, transect walks, and opportunistic sampling were employed to thoroughly record the species found in the 2-ha permanent plot of BTLNP. Herbaceous plants, epiphytic plants, hemi-epiphytic plants, vines, and lianas present in the area were listed and documented.

### Collection and Processing of Specimens

Plant collection involved uprooting herbs or cutting branches with reproductive parts (fruits and flowers). Specimens were pressed using the V-shaped and W-shaped method between unused newspapers, labeled with collection details, and stored in transparent cellophane bags with denatured alcohol. At Central Mindanao University, specimens were dried using a mechanical dryer with corrugated cardboard and twine for two weeks. Dried specimens were deposited at the Central Mindanao University Herbarium (CMUH) for accessioning, with a maximum of three individuals per species per site, as permitted by the WGP.

### Identification of Specimens and Assessment

Collected specimens were identified using field guides, online databases (such as JSTOR, Co's Digital Flora of the Philippines, Plant of the World Online, and the International Plant Name Index), and relevant literature (Fernando *et al.* 2004; Aribal 2013; Tandang *et al.* 2014; Malabrigo *et al.* 2016; Amoroso *et al*. 2018b; Acma *et al.* 2021). These resources enabled accurate species identification and confirmation.

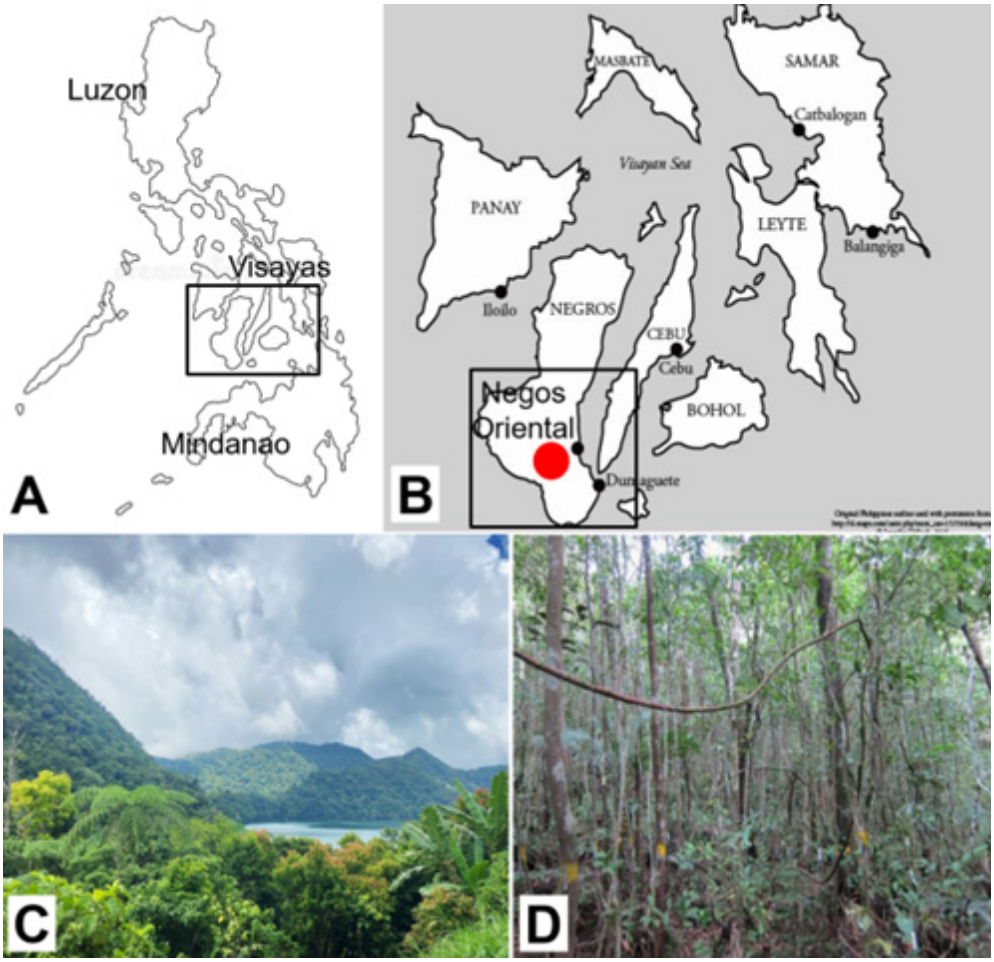


**Figure 1.** Study site: [A] map of the Philippines; [B] map of Central Visayas highlighting the Negros Oriental province (red dot); [C] panoramic view of Balinsasayao Twin Lakes, Sibulan, Negros Oriental; [D] portion of the permanent plot of BTLNP (Plot 0505).

**Assessment of Conservation Status and Endemism**

The conservation status of each species was assessed following the assessment of the DENR Administrative Order (DAO 2017-11), the International Union for Conservation of Nature's (IUCN) guidelines (IUCN 2024), and the book of Fernando *et al.* (2022). Endemicity was evaluated using Co's Digital Flora of the Philippines (Pelser *et al.* 2011 onwards), an online archive of plant species.

## RESULTS AND DISCUSSION

### Species Composition

This study recorded 101 species of understory flowering plants, comprising 74 genera and 32 families (Table 1; Figure 2). The documented species encompass a diverse range of growth forms – including herbs, vines, lianas, epiphytes, and palms. The collected data of understory flowering plants, with the given size of the area that is only 2 ha, has relatively high species richness. The species which dominated the area were *Piper* sp. 1 (Piperaceae), *Alocasia boyceana* A.Hay (Araceae), *Ophiorrhiza* sp. 1 (Rubiaceae), *Lasianthus clementis* Merr. (Rubiaceae), and *Curculigo capitulata* (Lour.) Kuntze (Hypoxidaceae).

At the family level, the most abundant taxa include Rubiaceae (12 species or 12%), Orchidaceae and Araceae (11 species for each family or 11%), and Zingiberaceae (8 species or 8%). This is because most of these species are food plants to some invertebrate fauna [*Aglaonema disenervium* Engl., *Alocasia heterophylla* (C.Presl) Merr., *Medinilla clementis* Merr., *Mycetia cauliflora* Reinw.], and these species are mostly occurring in some forest patches or secondary forests, which is the same to the report of Acma *et al.* (2021). The dominant plant families in this study align with the findings of Acma *et*

**Table 1.** Checklist of understory flowering plants of Balinsasayo Twin Lakes Natural Park, Negros Oriental, the Philippines.

| Family | Species |
|---|---|
| Acanthaceae | 1. *Strobilanthes reptans* (G.Forst.) Moylan ex. Y.F.Deng & J.R.I.Wood |
| Apocynaceae | 2. *Hoya incrassata* Warb. |
| | 3. *Hoya odorata* Schltr. |
| | 4. *Hoya* sp. |
| Araceae | 5. *Aglaonema disenervium* Engl. |
| | 6. *Aglaonema simplex* Blume |
| | 7. *Alocasia boyceana* A.Hay |
| | 8. *Alocasia heterophylla* (C.Presl) Merr. |
| | 9. *Homalomena philippinensis* Engl. Ex Engl. & K.Krause |
| | 10. *Pothos ovatifolius* Engl. |
| | 11. *Raphidophora monticola* K.Krause |
| | 12. *Raphidophora perkinsiae* Engl. |
| | 13. *Raphidophora philippinensis* Engl. & K.Krause |
| | 14. *Scindapsus pictus* Hassk. |
| | 15. *Schismatoglottis plurivenia* Alderw. |
| Araliaceae | 16. *Mackinlaya celebica* (Harms) Philipson |
| | 17. *Heptapleurum* sp. 1 |
| | 18. *Heptapleurum* sp. 2 |
| | 19. *Osmoxylon eminens* (W.Bull) Philipson |
| Arecaceae | 20. *Calamus aidae* Fernando |
| | 21. *Calamus discolor* Mart. |
| | 22. *Calamus* sp. |
| | 23. *Heterospathe negrosensis* Becc. |
| | 24. *Pinanga philippinensis* Becc. |
| Asteraceae | 25. *Blumea balsamifera* (L.) DC. |
| Begoniaceae | 26. *Begonia negrosensis* Elmer |
| Chlorantaceae | 27. *Chloranthus elatior* Link |
| | 28. *Sarcandra glabra* (Thunb.) Nakai |
| Commelinaceae | 29. *Pollia thyrsiflora* (Blume) Steud. |
| Convolvulaceae | 30. *Ipomoea boholensis* (Merr.) J.R.I.Wood & Scotland |
| Costaceae | 31. *Hellenia speciosa* (J.Koenig) Govaerts |
| Cyperaceae | 32. *Carex* sp. |
| | 33. *Machaerina falcata* (Nees) T.Koyama |
| Dioscoreaceae | 34. *Dioscorea* sp. |
| Ericaceae | 35. *Vaccinium cebuense* Salares & Pelser |
| Gesneriaceae | 36. *Aeschynanthus asclepoides* (Elmer) B.L.Burtt & P.Woods |
| | 37. *Aeschynanthus truncatus* (Elmer) Schltr |
| | 38. *Cyrtandra geantha* Kraenzl. |
| | 39. *Rhyncothecum discolor* (Maxim.) B.L.Burtt |
| Hydrangeaceae | 40. *Hydrangea chinensis* Maxim. |
| Hypoxidaceae | 41. *Curculigo capitulata* (Lour.) Kuntze |
| Lamiaceae | 42. *Clerodendrum minahassae* Teijsm. & Binn. |

**Table 1.** Cont.

| | | |
|---|---|---|
| | 43. | *Coleus scutellarioides* (L.) Benth. |
| Melastomataceae | 44. | *Medinilla clementis* Merr. |
| | 45. | *Medinilla teysmanii* Miq. |
| Malvaceae | 46. | Malvaceae unidentified species |
| Moraceae | 47. | *Ficus villosa* Blume |
| Musaceae | 48. | *Musa textilis* Nees |
| Orchidaceae | 49. | *Agrostophyllum saccatilabium* Ames & Quisumb. |
| | 50. | *Anoectochilus* sp. |
| | 51. | *Appendicula micrantha* Lindl. |
| | 52. | *Bulbophyllum* sp. |
| | 53. | *Calanthe mcgregorii* Ames |
| | 54. | *Crepidium ramosii* (Ames) Szlach. |
| | 55. | *Cylindrolobus* sp. |
| | 56. | *Dendrobium* sp. 1 |
| | 57. | *Dendrobium* sp. 2 |
| | 58. | *Dendrochilum* sp. |
| | 59. | *Pinalia cylindrostachya* (Ames) W.Suarez & Cootes |
| Pandanaceae | 60. | *Freycinetia negrosensis* Merr. |
| | 61. | *Freycinetia rostrata* Merr. |
| | 62. | *Freycinetia* sp. |
| | 63. | *Pandanus* sp. |
| Piperaceae | 64. | *Peperomia negrosensis* C.DC. |
| | 65. | *Piper lanatum* Roxb |
| | 66. | *Piper lessertianum* (Miq.) C.DC. |
| | 67. | *Piper* sp. |
| Primulaceae | 68. | *Ardisia* sp. |
| Poaceae | 69. | *Dinochloa pubiramea* Gamble |
| Rosaceae | 70. | *Rubus moluccanus* L. |
| Rubiaceae | 71. | *Argostemma solaniflorum* Elmer |
| | 72. | *Argostemma* sp. |
| | 73. | *Geophila repens* (L.) I.M. Johnst. |
| | 74. | *Hedyotis* sp. |
| | 75. | *Lasianthus clementis* Merr. |
| | 76. | *Lasianthus* sp. |
| | 77. | *Mycetia cauliflora* Reinw. |
| | 78. | *Mycetia javanica* (Blume) Reinw. Ex Korth |
| | 79. | *Ophiorrhiza lancilimba* Merr. |
| | 80. | *Ophiorrhiza* sp. |
| | 81. | *Psychotria cuernosensis* Elmer |
| | 82. | *Psychotria* sp. |
| | 83. | *Uncaria* sp. |
| Smilacaceae | 84. | *Smilax bracteata* C.Presl |
| Urticaceae | 85. | *Dendrocnide* sp. |

**Table 1.** Cont.

| | | |
|---|---|---|
| | 86. | *Elatostema* cf. *benguetense* C.B.Rob. |
| | 87. | *Elatostema sorsogonense* Elmer |
| | 88. | *Elatostema spinulosum* Elmer |
| | 89. | *Leukosyke negrosensis* C.B.Rob. |
| | 90. | *Oreocnide* sp. |
| Vitaceae | 91. | *Tetrastigma harmandii* Planch. in DC. |
| | 92. | *Tetrastigma papillosum* (Blume) Planch. |
| Zingiberaceae | 93. | *Adelmeria alpina* Elmer |
| | 94. | *Adelmeria gigantifolia* (Elmer) R.M.Sm. |
| | 95. | *Alpinia haenkei* C.Presl |
| | 96. | *Alpinia musifolia* Ridl. |
| | 97. | *Etlingera alba* (Blume) A.D.Poulsen |
| | 98. | *Etlingera pilosa* Poulsen & Docot |
| | 99. | *Hornstedtia conoidea* Ridl. |
| | 100. | *Hedychium philippinense* K.Schum. |
| | 101. | *Zingiber negrosense* Elmer |

*al.* (2021) in the Marilog District, where Zingiberaceae (26 species) was the most species-rich family – followed by Orchidaceae (19 species), Gesneriaceae (14 species), and Rubiaceae and Arecaceae (13 species each). The total number of understory plants documented in this study is relatively high compared to previous studies at Mt. Hamiguitan Range Wildlife Sanctuary (MHRWS) (Amoroso *et al.* 2018a, b) but lower than the 174 species reported by Acma *et al.* (2021).

This study reports a relatively high species richness of understory flowering plants, surpassing the numbers found in previous studies by Alava (2001), Agduma *et al.* (2011), and Aribal (2013). Notably, these earlier studies included a broader range of plant species such as trees, shrubs, ferns, and lycophytes, whereas this study focused solely on flowering understory plants. Despite this narrower focus, the current study reports more species than Alava (2001) in Mt. Mayapay (161 species), Agduma *et al.* (2011) in Platinum Rubber Plantation (101 species), and Aribal (2013) in Caimpugan Peat Swamp Forest (92 species).

The BTLNP is a second-growth forest characterized by a sparse canopy, limited understory vegetation, and sloping terrain (Aureo *et al.* 2020). Interestingly, the forest's history of disturbance may contribute to its surprisingly high species diversity, as research suggests that secondary forests with increased disturbance levels tend to support a greater variety of species (Zhu *et al.* 2007). However, it is still important to conserve and preserve this area as changes might affect the diversity of understory plants in the area such as the improvement of the road network, which could be one of the causes of forest fragmentation (Spellerberg 1998). Further, urbanization-driven changes to natural landscapes can have far-reaching consequences – including disruptions to plant and animal communities, pollinators, and ecological processes (Müller and Werner 2010; van Ham *et al.* 2013; Crompton 2016; Coldwell and Evans 2017; Grunewald *et al.* 2017). These changes can alter the composition and diversity of ecosystems, potentially undermining their resilience and function.

**Conservation Status and Endemism**

Conservation status assessment using the IUCN (2024) revealed two threatened species, namely *Hedychium philippinense* K.Schum. as endangered and *Aeschynanthus truncatus* (Elmer) Schltr. as vulnerable, and there are four species assessed as least concern. A total of 18 species (*ca.* 0.37% of the total Philippine endemic vascular flora) of understory flowering plants were Philippine endemics (Table 2; Figure 3). In the study of Acma *et al.* (2021), two threatened species (not including the least concern and data deficient species) of understory flowering plants were recorded in the Marilog District in Davao City, whereas 54 Philippine endemic species were recorded.

**Noteworthy Species**

*Anoectochilus* sp. (Orchidaceae) is found to be a new species and a new genus record in the Philippines after examining its detailed morphology. This orchid species was found terrestrially on the overlapping rocks inside the 2-ha permanent plot, with several individuals distributed


**Figure 2.** Some understory plants in Balinsasayao Twin Lakes Natural Park, Negros Oriental, the Philippines: [A] *Strobilanthes reptans* (G.Forst.) Moylan ex. Y.F.Deng & J.R.I.Wood; [B] *Hoya odorata* Schltr.; [C] *Pollia thyrsiflora* (Blume) Steud.; [D] *Amischotolype hispida*; [E] *Curculigo capitulata* (Lour.) Kuntze; [F] *Hydrangea chinensis* Maxim.; [G] *Medinilla teysmanii* Miq.; [H] *Anoectochilus* sp.; [I] *Calanthe mcgregorii*; [J] *Agrostophyllum* sp.; [K] *Peperomia* sp.; [L] *Ardisia* sp.; [M] *Argostemma solaniflorum* Elmer; [N] *Psychotria* sp.; [O] *Elatostema spinulosum* Elmer; [P] *Etlingera alba* (Blume) A.D.Poulsen. Scale bars: [A] 3 cm; [B–F, I–L] 5 cm; [G] 15 cm; [H] 3 cm; [M] 2 cm; [N–P] 7 cm. Photographs by N.P. Mendez.

on each sampling plot. On the other hand, *Elatostema sorsogonense* – a Philippine endemic species of Urticaceae – was documented for the first time after a lapse of several decades since its first description in 1934 in its type locality at Mt. Bulusan in Sorsogon. The collected specimens were compared to the Philippine materials of Urticaceae available at JSTOR and photographs on CDFP by Pelser *et al.* (2011 onwards) and hold a new distribution record in the Visayas Islands.

**Table 2.** Conservation Status and Endemism of Flowering Plants in Balinsasayo Twin Lakes Natural Park, Negros Oriental, the Philippines.

| Species | Conservation status (IUCN 2024) | Endemism |
|---|---|---|
| 1. *Hoya incrassata* Warb. | – | PE |
| 2. *Hoya odorata* Schltr. | – | PE |
| 3. *Alocasia boyceana* A.Hay | – | PE |
| 4. *Heterospathe negrosensis* Becc. | – | PE |
| 5. *Begonia negrosensis* Elmer | – | PE |
| 6. *Ipomoea boholensis* (Merr.) J.R.I.Wood & Scotland | – | PE |
| 7. *Aeschynanthus truncatus* (Elmer) Schltr. | VU | – |
| 8. *Psychotria cuernosensis* Elmer | – | PE |
| 9. *Leukosyke negrosensis* C.B.Rob. | – | PE |
| 10. *Elatostema sorsogonense* Elmer | – | PE |
| 11. *Adelmeria alpina* Elmer | – | PE |
| 12. *Adelmeria gigantifolia* (Elmer) R.M.Sm. | – | PE |
| 13. *Alpinia haenkei* C.Presl | – | PE |
| 14. *Alpinia musifolia* Ridl. | – | PE |
| 15. *Etlingera pilosa* Poulsen & Docot | – | PE |
| 16. *Hornstedtia conoidea* Ridl. | – | PE |
| 17. *Hedychium philippinense* K.Schum. | EN | PE |
| 18. *Zingiber negrosense* Elmer | – | PE |

Remarks: [EN] endangered; [VU] vulnerable; [PE] Philippine-endemic

The exact identity of *Zingiber negrosense* (Zingiberaceae), a Philippine endemic ginger species, was also confirmed in this study since BTLNP is located near its type locality. This makes the available photographs online invalid identities of this species, which creates confusion on the previous identity of this species. Further, *Hornstedtia conoidea* – also a Philippine endemic species – was also recorded for the first time on this Island, adding to Cebu province as the only recorded place in Visayas, where this species occurs.

## CONCLUSIONS AND RECOMMENDATIONS

This study has recorded a total of 101 morpho-species of understory flowering plants, which are distributed to 74 genera and 33 families. The family Rubiaceae (12%) obtained the highest number of species, whereas it was the lowest in Begoniaceae, Convolvulaceae, Costaceae, Dioscoreaceae, Ericaceae, Hydrangeaceae, Hypoxidaceae, Malvaceae, Moraceae, Musaceae, Primulaceae, Poaceae, Rosaceae, and Smilacaceae with 1 species (1%) on each family. Conservation status assessment revealed two threatened species (*Hedychium philippinense* K.Schum. as endangered and *Aeschynanthus truncatus* (Elmer) Schltr. as vulnerable). A total of 18 species (*ca.* 0.37% of the total Philippine endemic vascular flora) of understory flowering plants are endemic to the Philippines. These understory flowering plants were mostly growing in a forest over rock vegetation and mostly covered by leaf litter.

The findings of this study should be shared with the local government units (LGUs) and stakeholders of BTLNP to inform conservation efforts and protect the understory flowering plants in the area. Monitoring of understory flowering plants should also be done along with the monitoring of trees in BTLNP to properly record the changes of vascular plants in the area.

## ACKNOWLEDGMENTS

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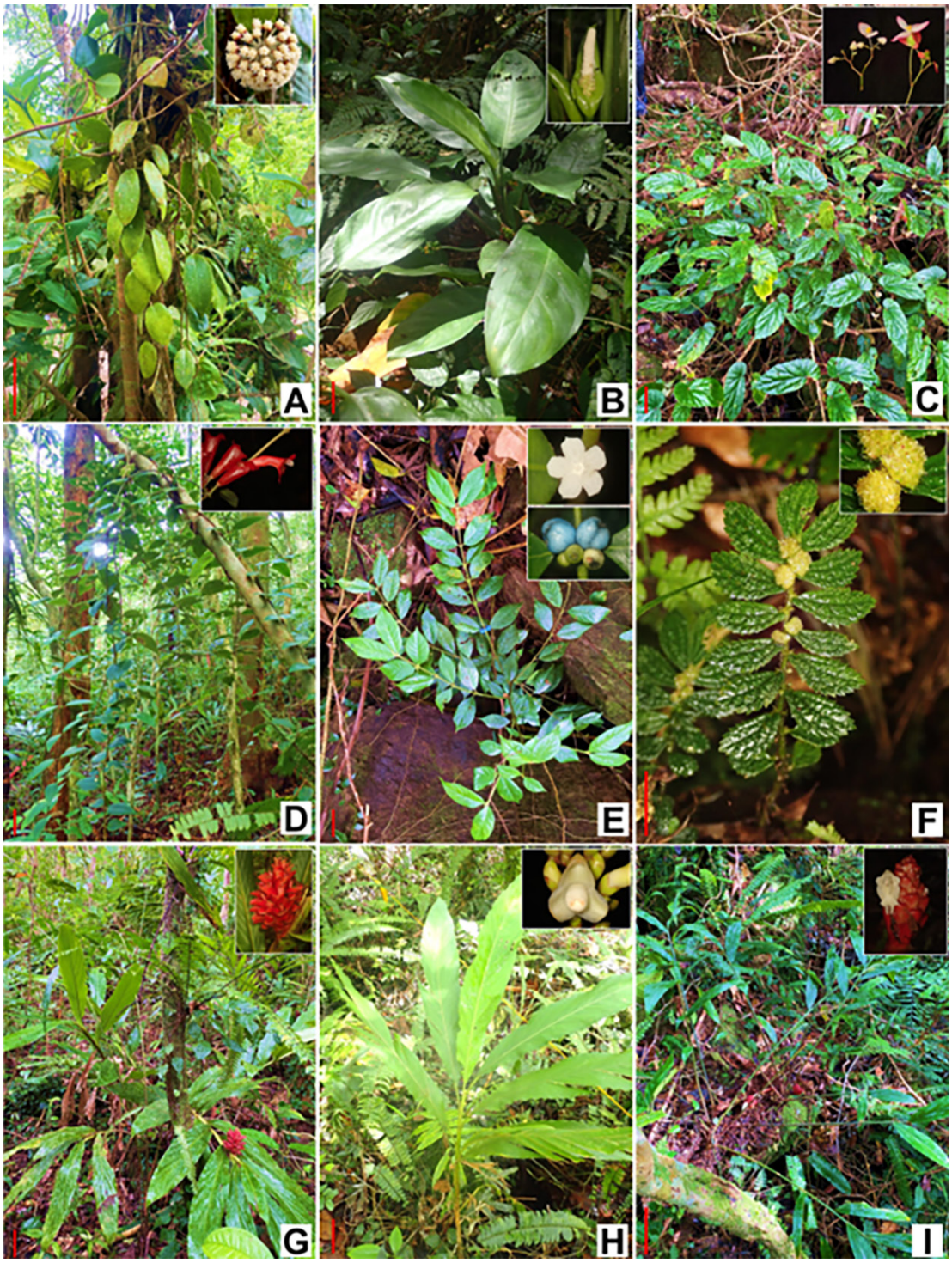


**Figure 3.** Some threatened and Philippine endemic species of understory flowering plants in Balinsasayao Twin Lakes Natural Park, Negros Oriental, the Philippines: [A] *Hoya incrassata* Warb.; [B] *Aglaonema disenervium* Engl.; [C] *Begonia negrosensis* Elmer; [D] *Aeschynanthus truncatus* (Elmer) Schltr.; [E] *Lasianthus clementis* Merr.; [F] *Elatostema sorsogonense* Elmer; [G] *Adelmeria gigantifolia* (Elmer) R.M.Sm.; [H] *Alpinia musifolia* Ridl.; [I] *Zingiber negrosense* Elmer. Scale bars: [A–E] 10 cm; [F] 3 cm; [G–I] 8 cm. Photographs by N.P. Mendez.

well as to the DENR Region VII Office for issuing the WGP. We also appreciate the collaboration and assistance of researchers from PhilBio, NOrSU, and SUAKCREM during the botanical expedition.

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